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मानक

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Mazdoor Kisan Shakti Sangathan

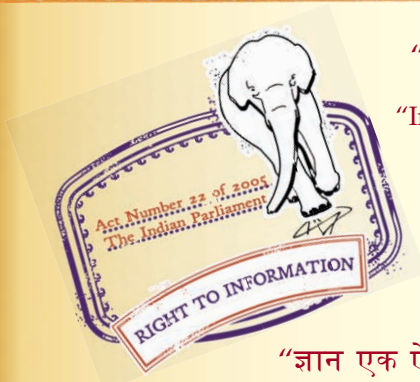
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“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 3601 (2006): Steel tubes for mechanical and general engineering purposes [MTD 19: Steel Tubes, Pipes and Fittings]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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यांत्रिकीय और सामान्य इंजीनियरिंग उद्देश्य के लिए
इस्पात नलिकाएँ — विशिष्टि
(दूसरा पुनरीक्षण)

Indian Standard
STEEL TUBES FOR MECHANICAL AND
GENERAL ENGINEERING PURPOSES —
SPECIFICATION
(*Second Revision*)

ICS 77.140.75

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Steel Tubes, Pipes and Fittings Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1966 and revised in 1984. While reviewing this standard, in light of the experience gained during these years, it was decided by the Committee to revise the standard with the following main modifications:

- a) All amendments to first revision of the standard incorporated;
- b) Grade 200 has been substituted by the grade 210 in all types of pipes;
- c) Grade 430 and 540 have been deleted for cold drawn seamless (CDS) pipes;
- d) Sulphur and phosphorus content in the ladle analysis of the steel has been brought down from 0.06 to 0.04 percent maximum in keeping with the trend of reducing impurities due to developments in the steel manufacturing technology;
- e) Tensile strength of grade WT 310 has been substituted by 450 MPa, minimum in place of 540 MPa, minimum and elongation in Table 2 for welded steel tubes have been modified depending upon the finishing condition of the tube;
- f) Tolerances on thickness of tubes above 152.4 and upto 168.3 mm and those of the above 168.3 mm outside diameter have been included; and
- g) Test requirements for distance between pallets in flattening test modified.

This standard is intended to cover the requirements for such steel tubes which do not require pressure testing.

In the formulation of this standard, assistance has been derived from the following publications:

- ISO 4200 : 1991 'Plain end steel tubes, welded and seamless — General tables of dimensions and masses per unit length', issued by the International Organization for Standardization
- BS 1775 : 1964 'Steel tubes for mechanical, structural and general engineering purposes', issued by the British Standards Institution

This standard contains clauses, which require the purchaser to supply certain technical information at the time of enquiry or placing orders. The relevant clauses have been listed in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

**AMENDMENT NO. 1 SEPTEMBER 2012
TO
IS 3601 : 2006 STEEL TUBES FOR MECHANICAL AND
GENERAL ENGINEERING PURPOSES —
SPECIFICATION**

(Second Revision)

(Page 3, clause 17.1, line 2) — Substitute ‘high frequency induction welded’ for ‘high frequency induction butt-welded’.

(Page 8, Table 6, table heading) — Substitute ‘HFIW or ERW Types’ for ‘HFW Types Only’.

(MTD 19)

Reprography Unit, BIS, New Delhi, India

Indian Standard

STEEL TUBES FOR MECHANICAL AND GENERAL ENGINEERING PURPOSES — SPECIFICATION (Second Revision)

1 SCOPE

1.1 This standard covers four types of carbon steel welded and seamless tubes given in Table 1 and sizes as recommended in Annex B.

1.1.1 This standard does not cover steel tubes for pressure purposes and for structural purposes, which are covered by separate Indian Standards.

1.2 Section 1 covers general requirements applicable to all the four types of steel tubes. Requirements regarding material, mechanical properties, dimensions, tolerances, and additional tests for each type of tubes are laid down in the relevant sections dealing with each type of tube. Any other special requirements may be agreed to between the purchaser and the manufacturer.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	Title
228	Methods of chemical analysis of pig iron, cast iron and plain carbon and low alloy steel (<i>revised</i>) (issued in parts)
1387 : 1993	General requirements for the supply of metallurgical materials (<i>second revision</i>)
1608 : 2005	Metallic materials — Tensile testing at ambient temperature (<i>third revision</i>)
2328 : 2005	Metallic materials — Tube — Flattening test (<i>second revision</i>)
2329 : 2005	Metallic materials — Tube (in full section) — Bend test (<i>second revision</i>)
2335 : 2005	Metallic materials — Tube — Drift expanding test (<i>second revision</i>)

IS No.

Title

2633 : 1986	Methods of testing uniformity of coating of zinc coated articles (<i>second revision</i>)
4711 : 1974	Methods of sampling of steel pipes, tubes and fittings (<i>first revision</i>)
10748 : 2004	Hot-rolled steel strip for welded tubes and pipes — Specification (<i>second revision</i>)

SECTION 1 GENERAL REQUIREMENTS APPLICABLE TO ALL THE FOUR TYPES OF STEEL TUBES

3 TYPES AND GRADES

3.1 Types and grades of the steel tubes for mechanical and general engineering purposes shall be based on the process of manufacture and minimum yield stress, in MPa, as given in Table 1.

3.2 Steel tubes are designated by symbols to indicate the process of manufacture, followed by the minimum yield stress, in MPa. For example, hot finished welded tubes having a minimum yield stress of 210 MPa are designated as HFW 210.

4 MATERIAL

4.1 The ladle analysis of steel shall not show either sulphur or phosphorus more than 0.040 percent, when carried out either by the method specified in relevant parts of IS 228 or any other established instrumental/chemical method. In case of dispute the method given in relevant parts of IS 228 shall be the referee method.

4.1.1 Wherever applicable steel sheets or strips of any suitable grade to IS 10748 may be used in manufacturing the tubes of above mentioned grades.

4.2 Check Analysis

When specified on the purchase order, a check analysis shall be made by the supplier. The permissible variation in case of check analysis from the limits

specified in 4.1 shall be as follows:

<i>Constituents</i>	<i>Percent, Max</i>
Sulphur	0.005
Phosphorus	0.005

5 SUPPLY OF MATERIAL

General requirements relating to the supply of steel tubes for mechanical and general engineering purposes shall conform to IS 1387.

6 WORKMANSHIP

All tubes shall be free from harmful defects, reasonably smooth and free from loose scale and rust. Unless otherwise specified, ends shall be cut square.

7 MACHINING

Where tubes are required to be machined, finished dimensions shall be stated in the enquiry and order. It is recommended that the method of machining should also be stated.

8 STRAIGHTNESS

Unless otherwise tolerances are agreed to between the purchaser and the manufacturer, tubes shall not deviate from straightness by more than 1/600 of any length, measured at the centre of that length.

9 LENGTH

9.1 Tubes shall be supplied in random lengths from 4 to 7 m. Wherever the exact length requirement is there, it will be subject to agreement between the manufacturer and the purchaser.

9.2 For orders over 150 m of any one size of tube, it shall be permissible unless otherwise agreed to between the purchaser and the manufacturer, to supply short random lengths in the range 1.8 to 4 m provided that the number of such lengths does not exceed 7.5 percent of the total number of lengths for sizes 76.2 to 114.3 m outside diameter inclusive and 5 percent for all other sizes.

10 DIMENSIONS AND PROPERTIES

Recommendations on outside diameter and thickness of the tubes are given in Annex B. However, any other outside diameter and thickness as agreed to between the manufacturer and the purchaser may be supplied. The design properties of these tubes are given in Annex B for guidance.

11 SURFACE PROTECTION

11.1 Unless otherwise specified tubes shall be supplied uncoated or with manufacturer's standard mill protective coating.

11.2 When tubes are to be galvanized, they shall first

be thoroughly descaled and then dipped in a bath of molten zinc (containing not more than 2.5 percent of impurities) at a temperature suitable to produce a complete and uniformly adherent coating of zinc. The galvanizing shall be capable of passing the test specified in IS 2633. Specific requirement for galvanizing shall be subject to mutual agreement between the purchaser and the manufacturer.

12 TESTING

12.1 The manufacturer shall carry out the specified tests applicable to each type of tubes, and shall, if required by the purchaser, supply a certificate stating that the tubes comply with the specified requirements. When the purchaser desires such certificate, this shall be stated in the enquiry and order.

12.2 When the purchaser requires additional tests related to his order, such tests shall be subject to agreement between the purchaser and the manufacturer.

13 MECHANICAL TESTING

The following tests, where applicable, shall be carried out.

13.1 Tensile Test

This should be carried out in accordance with IS 1608 on one of the following at the manufacturers option:

- A length cut from the end of the selected tube (the ends being plugged for grips or flattened where necessary); and
- A longitudinal strip cut from the tube and tested in the curved conditions, or a test piece cut circumferentially and flattened before testing. For welded tubes, the test piece should be from the location approximately 90°, away from the weld.

13.1.1 The tensile strength, the yield stress and the percentage elongation shall not be less than those specified in the appropriate section.

13.1.2 The percentage elongation is specified in this standard and shall be reported with reference to a gauge length of $5.65\sqrt{S_0}$ where $\sqrt{S_0}$ is the original cross-sectional area of the test specimen.

13.1.3 The tensile strength shall be the actual value obtained from the test piece.

13.2 Flattening Test

13.2.1 Flattening test shall be carried out above sizes of 60.3 mm, outside diameter in accordance with IS 2328.

13.2.2 A ring not less than 40 mm in length, cut from the end of the tube shall withstand, without showing either crack or flaw, being cold flattened between

parallel plates until, the distance between the platens is not greater than that specified in the appropriate section. Slight premature failure at the edges shall not be considered a cause for rejection. Burrs shall be removed before testing. Sample shall not have ends cut by oxyacetylene flame.

13.2.3 Welded tubes shall have the weld placed at 90° to the direction of flattening.

13.3 Bend Test (Strip)

13.3.1 A strip not less than 38 mm wide, cut circumferentially from one end of the tube, when cold, be bent approximately 180° in the direction of original curvature round a bar of the diameter specified in the appropriate section, without showing either crack or flaw. Slight premature failures at the edges of a specimen shall not be considered a cause for rejection.

13.3.2 For sample cutting, high temperature cutting method shall not be used to avoid changes in mechanical properties in heat affected zone.

13.4 Bend Test, Whole Tube

13.4.1 The test shall be carried out in accordance with IS 2329. The tubes shall be bent cold, by means of a tube bending machine round a grooved former having at the bottom of the groove the radius specified in the appropriate section. The tubes shall not be filled. The weld shall be at 90° to the plane of bending. The tube shall show no sign of crack or flaw as a result of this test.

13.4.2 The maximum outside diameter of the tube above which bend test of whole tube may not be carried out is 60.3 mm.

13.5 Drift Expansion Test

13.5.1 The test shall be carried out in accordance with IS 2335. A piece of tube approximately 100 mm long cut from one end shall be expanded cold, by means of a conical drift having an included angle of 30° or 45° or 60° until outside diameter of the tube at the mouth has been increased by not less than the percentage specified in the appropriate section. Belling of the tubes by spinning methods is not permissible. The tube shall show no sign of crack or flaw as a result of this test.

13.5.2 The choice of drift cone angle is the option of the manufacturer.

13.6 Crushing Test

A piece of tube approximately equal length to 1.5 times the diameter, cut from one end, with the ends parallel and square with its axis, shall be crushed cold, length wise until its lengths reduce by not less than the percentage of the original length specified in the appropriate section. The tube shall show no sign of crack or flaw as a result of this test.

14 RE-TEST

14.1 Should a tube selected for test fail in any one or more of the tests specified, two further tests of the same kind shall be made from the same or another tube at the manufacturer's discretion.

14.2 If both the repeat tests are satisfactory the tubes shall be accepted provided that in all respects they comply with the requirements of this standard. If failure occurs in either of the re-tests, the tubes represented by these test pieces shall be deemed not conforming to this standard.

14.3 If the tubes represented have been subjected to heat treatment, they may be re-heat treated and tested in accordance with 12.

15 SAMPLING FOR TUBES

15.1 Lot for purpose of drawing samples all tubes bearing same designation and manufactured under a single process shall be grouped together to constitute a lot. Each lot shall be sampled separately and assessed for conformity to this standard.

15.2 Sampling and Criterion for Conformity

Unless otherwise agreed to between the manufacturer and the purchaser the procedure for sampling of tubes for various tests and criteria for conformity, IS 4711 shall be followed. Re-test in case of failure shall be carried out as per 1.4.

16 MARKING

Each tube may be marked with manufacturers name and trade-mark, type and grade of tube. Alternatively label containing particulars may be attached to the bundle.

16.1 BIS Certification Marking

The tubes may also be marked with the Standard Mark.

16.1.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of the Standard Mark may be granted to the manufacturers or producers may be obtained from the Bureau of Indian Standards.

SECTION 2 WELDED STEEL TUBES

17 GENERAL

17.1 This section covers requirements for hot finished welded steel tubes, electric resistance welded or high frequency induction butt-welded steel tubes and oxyacetylene welded tubes in as welded, welded and annealed/normalized condition.

18 MECHANICAL PROPERTIES

The mechanical properties of welded tubes when tested in accordance with 13.1 shall conform to the requirements given in Table 2.

19 TOLERANCES

19.1 Tubes shall conform to the following tolerances.

19.1.1 Outside Diameter

a) For the tubes manufactured by HFW process:

<i>Sl No.</i>	<i>Outside Diameter</i>	<i>Tolerances</i>
1)	Sizes up to and including 40 mm	+ 0.5 mm - 1.0
2)	Sizes over 40 mm	± 1 percent

b) For the tubes manufactured by ERW/HFIW processes and OAW process:

- 1) Where the ratio of outside diameter to thickness is not greater than 33:1, the tolerances shall be as shown in Table 4.
- 2) Where the ratio of outside diameter to thickness is greater than 33:1 the tolerance shall be as agreed to between the purchaser and the manufacturer.

19.1.2 Thickness

The tolerance on thickness excluding the weld shall be ± 10 percent.

19.1.3 The height of internal fin in case of ERW/HFIW tubes shall be not greater than 60 percent of the specified thickness. In case internal fin is required to be cut the maximum fin height is to be as agreed to between the manufacturer and the purchaser.

20 OTHER TESTS

In addition to the tensile test as specified in 13.1 each selected tube, when tested in accordance with either 13.2 or 13.4 or 13.5 as appropriate shall satisfy the requirements laid down in Tables 5, 6 and 7.

SECTION 3 HOT FINISHED SEAMLESS STEEL TUBES (HFS)

21 GENERAL

21.1 This section covers requirements for hot finished seamless steel tubes of sizes up to and including 406.4 mm outside diameter.

21.2 During fabrication (erection and commissioning), tubes of Grade 310 may require special welding technique and these should be the subject of agreement between the purchaser and the manufacturer.

22 MECHANICAL PROPERTIES

The mechanical properties of HFS steel tubes when tested in accordance with 13.1 shall conform to the requirements laid down in Table 8.

23 DIMENSIONS AND PROPERTIES

23.1 Dimensions of the tubes most commonly used are given in Table 9. Any other size may be agreed to between the purchaser and the manufacturer.

23.1.1 Design properties of the tubes are given in Annex B for guidance only.

24 TOLERANCES

24.1 Tubes shall conform to the following tolerances.

24.1.1 Outside Diameter Tolerances

Sizes up to and including 48.3 mm outside diameter	: +0.5 mm -1.0
Sizes over 48.3 mm outside diameter	: ±1 percent

24.1.2 Thickness

Up to and including 3 percent of outside diameter	: ±15 percent
Over 3 percent of outside diameter up to and including 10 percent	: +15 percent -12.5
Over 10 percent for tubes upto and including 168.3 mm, outside diameter	: ±12.5 percent
Over 10 percent for tubes above 168.3 mm, outside diameter	: ±10 percent

25 OTHER TESTS

25.1 In addition to the tensile test specified in 13.1 at the option of the manufacturer and dependent upon the dimensions, the tube subjected to either flattening test or strip bend test in accordance with 13.2 or 13.3 shall satisfy the requirements as laid down in 25.2 and 25.3.

25.2 The distance between the platens shall be not greater than the value calculated from the formula:

$$H = \frac{(1 + C) a}{C + a/D}$$

where

- H = distance between platens,
- D = specified outside diameter,
- a = specified wall thickness, and
- C = constant depending upon the designation (see Table 10).

25.3 Bend test (strip) shall satisfy the requirements of Table 11.

SECTION 4 COLD DRAWN SEAMLESS STEEL TUBES (CDS)

26 GENERAL

26.1 This section covers requirements for cold drawn seamless steel tubes of size upto 406.4 mm outside diameter in hot finished welded, electric resistance welded or high frequency induction welded tubes in welded and annealed or normalized condition.

26.2 Tubes of Grades 160, 210, 240, 370 and 430 may be welded by ordinary techniques. During fabrication, the tubes of Grades 310, 430 and 540 may require special welding techniques and these should be the subject to agreement between the purchaser and the manufacturer.

27 MECHANICAL PROPERTIES

The mechanical properties of CDS steel tubes when tested in accordance with **13.1** shall conform to the requirements as laid down in Table 12.

28 TOLERANCES

28.1 The following manufacturing tolerances shall not be exceeded.

28.1.1 Outside Diameter

- Where the ratio of outside diameter to thickness is not greater than 33:1, the tolerances shall be as shown in Table 13.
- For sizes larger than 127.0 mm outside diameter, the tolerances shall be ± 0.08 mm, +0.05 per 25 mm of outside diameter or part thereof.
- Where ratio of outside diameter to thickness is greater than 33:1, the tolerance shall be agreed to between the purchaser and the manufacturer.

28.1.2 Thickness

The tolerance on thickness shall be ± 10 percent.

28.1.3 Bore

Where the tubes are ordered to bore dimensions, the tolerances shall be agreed to between the purchaser and the manufacturer.

29 OTHER TESTS

29.1 In addition to the tensile test specified in **13.1** annealed or normalized tubes shall be subjected to flattening test and crushing tests as given in **13.2** and **13.6** respectively which shall satisfy the requirements of **29.2** and **29.3** respectively (see Table 14).

29.2 The distance between the plates shall be not greater than the value calculated from the formula:

$$H = \frac{(1 + C) a}{C + a/D}$$

where

- H = distance between plates,
 D = specified outside diameter, and
 a = specified wall thickness.

29.3 Crushing test carried out on tubes in annealed and/or normalized condition shall have the test requirements as provided in Table 15.

SECTION 5 COLD DRAWN ELECTRIC RESISTANCE WELDED STEEL TUBES AND HIGH FREQUENCY INDUCTION BUTT WELDED STEEL TUBES (CEW)

30 GENERAL

30.1 This section covers requirements for cold drawn electric resistance welded steel tubes or high frequency induction butt welded steel tubes.

30.2 Tubes may be welded by ordinary techniques.

30.2.1 Tubes shall be made by cold drawing electric resistance welded steel tubes or high frequency induction welded steel tubes.

31 CONDITION

31.1 Tubes of Grades CEW 160, 210 and 240 shall be supplied in either annealed or normalized condition.

31.2 Tubes of Grades CEW 370 and 430 shall be supplied in either 'as drawn' or 'as drawn and tempered' condition at the option of the purchaser.

32 MECHANICAL PROPERTIES

Mechanical properties of CEW steel tubes when tested in accordance with **13.1** shall conform to the requirements as laid down in Table 16.

33 TOLERANCES

33.1 Tubes shall conform to the following tolerances.

33.1.1 Outside Diameter

- Where the ratio of the outside diameter to thickness is not greater than 33:1 the tolerances shall be as shown in Table 17.
- Where the ratio of outside diameter to thickness is greater than 33:1, the tolerances shall be agreed to between the purchaser and the manufacturer.

33.1.2 Thickness

The tolerance on thickness shall be ± 8 percent.

33.1.3 Bore

Where the tubes are ordered to bore dimensions, the tolerances shall be agreed to between the purchaser and the manufacturer.

34 OTHER TESTS

34.1 In addition to the tensile test specified in 13.1 annealed or normalized tubes shall be subjected to the flattening test as given in 13.2, the drift expansion test as given in 13.5 and the crushing test as given in 13.6.

The tests shall satisfy the requirements as given in 34.2, 34.3 and 34.4.

34.2 Flattening Test

The distance between the plates shall be not greater than the original outside diameter as given in Table 18.

34.3 Drift Expansion Test

The tube shall satisfy the requirements of Table 19.

34.4 Crushing Test

The crushing test shall satisfy the requirements of Table 20.

Table 1 Types and Grades of Steel Tubes
(Clauses 1.1 and 3.1)

Sl No.	Section	Type	Grade
(1)	(2)	(3)	(4)
i)	2	Welded tubes (WT) This includes hot finished welded (HFW) tubes, electric resistance welded or high frequency induction welded (ERW or HFIW) tubes and oxy-acetylene welded (OAW) tubes	160, 210, 240 and 310
ii)	3	Hot finished seamless (HFS) tubes	160, 210, 240 and 310
iii)	4	Cold drawn seamless (CDS) tubes	160, 210, 240, 310, 370, 430 and 540
iv)	5	Cold drawn electric resistance welded (CEW)	160, 210, 240, 310, 370 and 430

Table 2 Mechanical Properties
(Clause 18)

Sl No.	Tube Designation	Tensile Strength <i>Min</i>	Yield Stress <i>Min</i>	Elongation, Percent, <i>Min</i> on $GL = 5.65 \sqrt{S_o}$
(1)	(2)	(3)	(4)	(5)
i)	WT 160	310	160	Table 3
ii)	WT 210	330	210	
iii)	WT 240	410	240	
iv)	WT 310	450	310	

NOTES

- 1 If tubes in the as welded condition are subjected to annealing, brazing, welding or similar heating, these properties will deviate in the heat affected zone.
- 2 Welding of WT 310 Grade may require special welding technique.
- 3 S_o = Original cross-sectional area.
- 4 GL = Gauge length in mm.
- 5 1MPa = 0.102 0 kgf/mm².

Table 3 Elongation Percent, Minimum on $GL = 5.65 \sqrt{S_0}$
(Table 2)

Sl No.	Tube Designation	Hot Finished Annealed or Normalized	ERW, HFIW or OAW	
			As Welded (Less than or Equal to 33.7 mm OD)	As Welded (More than 33.7 mm OD)
(1)	(2)	(3)	(4)	(5)
i)	WT 160	25	15	22
ii)	WT 210	24	12	20
iii)	WT 240	22	10	15
iv)	WT 310	20	6	10

Table 4 Manufacturing Tolerances
(Clause 19.1.1)

Sl No.	Over mm	Up to and Including mm	Tolerance on Outside Diameter mm
(1)	(2)	(3)	(4)
i)	—	25.4	± 0.15
ii)	25.4	51.0	± 0.18
iii)	51.0	63.5	± 0.25
iv)	63.5	76.1	± 0.25
v)	76.1	88.9	± 0.31
vi)	88.9	101.6	± 0.36
vii)	101.6	114.3	± 0.43
viii)	114.3	152.4	± 0.58
ix)	152.4	168.3	± 0.65
x)	168.3	—	± 0.75

Table 5 Test Requirements for Flattening Test on Tubes
(Clause 20)

Sl No.	Tube Designation	Distance Between Platens <i>D</i>
(1)	(2)	(3)
i)	WT 160	½
ii)	WT 210	⅔
iii)	WT 240	¾
iv)	WT 310	¾

where *D* = outside diameter of tube.

Table 6 Test Requirement for Bend Test of Whole Tubes (Up to and Including 60.3 mm Outside Diameter for the Tubes Manufactured from HFW Types Only)*(Clause 20)*

SI No.	Condition of Tubes	Radius of Former	Angle of Bend Degree
(1)	(2)	(3)	(4)
i)	Black	6	180
ii)	Galvanized	8	90

Table 7 Requirements of Drift Expansion Test (Up to and Including 168.3 mm Outside Diameter and Thickness 1 to 9.53 mm)*(Clause 20)*

SI No.	Tube Designation	Increase on Outside Diameter, Percent
(1)	(2)	(3)
i)	WT 160 and WT 210	12.0
ii)	WT 240	10.0
iii)	WT 310	8.0

NOTE — This test is not applicable for HFW tubes.

Table 8 Mechanical Properties*(Clause 22)*

SI No.	Tube Designation	Tensile Strength <i>Min</i> MPa	Yield Stress <i>Min</i> MPa	Elongation Percent, <i>Min</i> on $GL = 5.65\sqrt{S_o}$
(1)	(2)	(3)	(4)	(5)
i)	HFS 160	310	160	25
ii)	HFS 210	330	210	24
iii)	HFS 240	410	240	22
iv)	HFS 310	450	310	20

NOTES

1 S_o = Original cross-sectional area.

2 GL = Gauge length, in mm.

3 1 MPa = 0.102 0 kgf/mm².

Table 9 Sizes of Hot Finished Seamless Steel Tubes
(Clause 23.1)

Sl No.	Approximate Outside Diameter mm	Thickness mm				
		(3)	(4)	(5)	(6)	(7)
i)	42.4	3.2	4.0	5.4	—	—
ii)	48.3	3.2	4.0	5.0	5.9	—
iii)	60.3	3.6	4.5	5.0	6.3	—
iv)	76.1	3.6	4.5	5.4	6.3	—
v)	88.9	4.0	5.0	5.4	6.3	—
vi)	101.6	4.0	5.0	6.3	—	—
vii)	114.3	4.5	5.4	6.3	8.0	—
viii)	127.0	4.5	5.0	5.4	—	—
ix)	139.7	4.5	5.0	5.4	6.3	8.0
x)	152.4	4.5	5.0	5.4	—	—
xi)	165.1	4.5	5.0	5.4	6.3	—
xii)	168.3	4.5	5.0	5.4	6.3	—
xiii)	193.7	5.0	5.4	6.3	8.0	8.0
xiv)	219.1	5.0	5.6	6.3	—	—
xv)	244.5	5.9	7.1	8.0	—	—
xvi)	273.0	6.3	7.1	9.5	—	—
xvii)	323.9	7.1	8.0	9.5	—	—
xviii)	355.6	9.5	12.5	—	—	—
xix)	406.4	9.5	12.5	—	—	—

Table 10 Constant for Flattening Test
(Clause 25.2)

Sl No.	Tube Designation	Constant (C)
(1)	(2)	(3)
i)	HFS 160	0.09
ii)	HFS 210	0.09
iii)	HFS 240	0.07
iv)	HFS 310	0.06

NOTE — Surface defects revealed during flattening test shall be removed by grinding and the remaining wall thickness shall not be less than the minimum thickness permissible.

Table 11 Test Requirements for Bend Test (Strip)
(Clause 25.3)

Sl No.	Tube Designation	Diameter of Bar	
		Tubes Up to and Including 9.5 mm Thickness	Tubes Over 9.5 mm Thickness
(1)	(2)	(3)	(4)
i)	HFS 160 and 210	3 <i>a</i>	4 <i>a</i> or two-thirds the inside diameter, whichever is smaller
ii)	HFS 240	4 <i>a</i>	5 <i>a</i> or seven-tenths the inside diameter whichever is smaller
iii)	HFS 310	5 <i>a</i>	6 <i>a</i> or three quarters the inside diameter whichever is smaller

NOTE — *a* = Thickness of tubes, mm.

Table 12 Mechanical Properties
(Clause 27)

Tube Designation	Tensile Strength <i>Min</i> MPa	Yield Stress <i>Min</i> MPa	Elongation, Percent, <i>Min</i> on $GL = 5.65\sqrt{S_u}$
(1)	(2)	(3)	(4)
<i>As normalized or annealed condition:</i>			
CDS 160	310	160	25
CDS 210	330	210	24
CDS 240	410	240	22
CDS 310	450	310	20
<i>As drawn or as drawn and stress relieved condition at the option of the manufacturer:</i>			
CDS 370 ¹⁾	410	370	6
CDS 430 ¹⁾	540	430	5
CDS 540 ¹⁾	650	540	4

¹⁾ If as drawn or as drawn and stress relieved/tempered tubes are subjected to annealing, brazing, welding or similar heating, these properties will be reduced in the heat affected zone.

Table 13 Manufacturing Tolerances
(Clause 28.1.1)

SI No.	Over mm	Up to and Including mm	Tolerance on Outside Diameter mm
(1)	(2)	(3)	(4)
i)	—	25.4	± 0.13
ii)	25.4	38.1	± 0.15
iii)	38.1	51.0	± 0.18
iv)	51.0	63.5	± 0.20
v)	63.5	76.1	± 0.23
vi)	76.1	88.9	± 0.25
vii)	88.9	101.6	± 0.28
viii)	101.6	114.3	± 0.31
ix)	114.3	127.0	± 0.33

Table 14 Constant for Flattening Test
(Clause 29.1)

SI No.	Tube Designation	Constant (C)
(1)	(2)	(3)
i)	CDS 160	0.10
ii)	CDS 210	0.09
iii)	CDS 240	0.07
iv)	CDS 310	0.06

NOTE — Surface defects revealed during flattening test shall be removed by grinding and the remaining wall thickness shall not be less than the minimum thickness permissible.

Table 15 Test Requirement for Crushing Test
(Clause 29.3)

SI No.	Tube Designation	Minimum Reduction of Original Length After Crushing, Percent
(1)	(2)	(3)
i)	CDS 160	50
ii)	CDS 210	50
iii)	CDS 240	25
iv)	CDS 310	25

Table 16 Mechanical Properties
(Clause 32)

Tube Designation	Tensile Strength <i>Min</i> MPa	Yield Stress <i>Min</i> MPa	Elongation, Percent, <i>Min</i> on $GL = 5.65\sqrt{S_0}$
(1)	(2)	(3)	(4)
<i>As normalized or annealed condition</i>			
CEW 160	310	160	25
CEW 210	330	210	24
CEW 240	410	240	22
<i>As drawn or drawn and stress relieved/tempered condition</i>			
CEW 370 ¹⁾	410	370	6
CEW 430 ¹⁾	540	430	5

¹⁾ If tubes of these grades are subjected to annealing, brazing, welding or similar heating these properties will be reduced in the heat affected zone.

Table 17 Tolerances
(Clause 33.1.1)

SI No.	Over mm	Up to and Including mm	Tolerance on Outside Diameter mm
(1)	(2)	(3)	(4)
i)	—	25.4	± 0.13
ii)	25.4	38.1	± 0.15
iii)	38.1	51.0	± 0.18
iv)	51.0	63.5	± 0.20
v)	63.5	76.1	± 0.23
vi)	76.1	88.9	± 0.25
vii)	88.9	101.6	± 0.28
viii)	101.6	114.3	± 0.31

Table 18 Distance Between Plates for Flattening Test
(Clause 34.2)

SI No.	Tube Designation	Distance Between Plates <i>D</i>
(1)	(2)	(3)
i)	CEW 160	$\frac{1}{2}$
ii)	CEW 210	$\frac{2}{3}$
iii)	CEW 240	$\frac{3}{4}$

Table 19 Drift Expansion Test*(Clause 34.3)*

Sl No.	Tube Designation	Minimum Expansion of Outside Diameter, Percent
(1)	(2)	(3)
i)	CEW 160	12
ii)	CEW 210	12
iii)	CEW 240	10

Table 20 Test Requirements for Crushing Test*(Clause 34.4)*

Sl No.	Tube Designation	Reduction of Original Length After Crushing, Annealed/Normalized, Percent	As Drawn or Drawn and Stress Relieved/ Tempered
(1)	(2)	(3)	(4)
i)	CEW 160	50	—
ii)	CEW 210	50	—
iii)	CED 240	50	—
iv)	CEW 370	—	25
v)	CEW 430	—	25

ANNEX A*(Foreword)***INFORMATION TO BE SUPPLIED BY THE PURCHASER**

A-1 The following information to be supplied by the purchaser:

- a) Types and grades (*see* 3 and Table 1),
- b) Size (*see* 10 and 23.1),
- c) Length in which tubes are to be supplied (*see* 9 and 11),
- d) Special requirements of surface coating, if desired (*see* 12),
- e) Whether test certificate is desired (*see* 12.1),
- f) Height of internal fin (*see* 19.1.3), and
- g) Any special welding technique desired (*see* 26.2).

ANNEX B

(Clauses 1.1, 10 and 23.1.1)

DIMENSIONS AND DESIGN PROPERTIES OF STEEL TUBES

<i>Outside Diameter</i> mm (1)	<i>Thickness</i> mm (2)	<i>Mass</i> kg/m (3)	<i>Area of Cross-Section</i> cm ⁴ (4)	<i>Moment of Inertia</i> cm ⁴ (5)	<i>Modulus of Section</i> cm ³ (6)	<i>Radius of Gyration</i> cm (7)
21.3	1.8	0.866	1.10	0.53	0.50	0.69
	2.0	0.952	1.21	0.57	0.54	0.69
	2.6	1.20	1.53	0.68	0.64	0.67
	3.2	1.43	1.82	0.77	0.72	0.65
	4.0	1.71	2.17	0.86	0.81	0.63
26.9	1.8	1.11	1.42	1.12	0.83	0.89
	2.0	1.23	1.56	1.22	0.91	0.88
	2.3	1.40	1.78	1.36	1.01	0.87
	2.6	1.56	1.98	1.48	1.10	0.86
	3.2	1.87	2.38	1.70	1.27	0.85
	4.0	2.26	2.88	1.95	1.45	0.82
33.7	2.0	1.56	1.99	2.51	1.49	1.12
	2.3	1.78	2.27	2.81	1.67	1.11
	2.6	1.99	2.54	3.09	1.84	1.10
	3.2	2.41	3.07	3.60	2.14	1.08
	4.0	2.93	3.73	4.19	2.49	1.06
	4.5	3.24	4.13	4.51	2.68	1.05
42.4	2.3	2.27	2.90	5.85	2.76	1.42
	2.6	2.55	3.25	6.46	3.05	1.41
	3.2	3.09	3.94	7.62	3.59	1.39
	3.6	3.44	4.39	8.33	3.93	1.38
	4.0	3.79	4.83	8.90	4.24	1.36
	5.0	4.61	5.87	10.45	4.93	1.33
	5.4	4.93	6.34	11.38	5.36	1.32
48.3	2.3	2.61	3.32	8.80	3.64	1.63
	2.6	2.93	3.73	9.77	4.05	1.62
	2.9	3.25	4.14	10.70	4.43	1.61
	3.2	3.56	4.53	11.59	4.80	1.60
	3.6	3.97	5.05	12.69	5.25	1.59
	4.0	4.37	5.57	13.77	5.70	1.57
	4.9	5.24	6.64	15.99	6.63	1.55
	5.0	5.34	6.80	16.15	6.69	1.54
	5.6	5.90	7.51	17.41	7.21	1.52
	5.9	6.16	7.86	18.20	7.54	1.52

<i>Outside Diameter</i> mm (1)	<i>Thickness</i> mm (2)	<i>Mass</i> kg/m (3)	<i>Area of Cross-Section</i> cm ⁴ (4)	<i>Moment of Inertia</i> cm ⁴ (5)	<i>Modulus of Section</i> cm ³ (6)	<i>Radius of Gyration</i> cm (7)
60.3	2.3	3.29	4.19	17.65	5.85	2.05
	2.6	3.70	4.71	19.64	6.51	2.04
	2.9	4.11	5.23	21.59	7.16	2.03
	3.2	4.51	5.74	23.47	7.78	2.02
	3.6	5.03	6.41	25.87	8.58	2.01
	4.0	5.55	7.07	28.15	9.34	2.00
	4.5	6.19	7.89	30.9	10.2	1.98
	5.0	6.82	8.7	33.48	11.1	1.96
	5.6	7.55	9.62	36.36	12.06	1.94
	6.3	8.39	10.6	39.8	13.2	1.92
76.1	2.6	5.24	6.00	40.57	10.66	2.60
	2.9	5.75	6.67	44.74	11.76	2.59
	3.2	6.44	7.33	48.78	12.8	2.58
	3.6	7.11	8.20	54.01	14.2	2.57
	4.5	7.95	10.1	65.12	17.1	2.54
	5.0	8.77	11.16	70.87	18.63	2.52
	5.4	9.42	11.9	75.4	19.8	2.52
	6.3	10.8	13.8	85.8	22.5	2.48
	7.1	12.1	15.38	92.50	24.31	2.45
88.9	2.9	6.15	7.83	72.47	16.30	3.04
	3.2	6.76	8.62	79.21	17.8	3.03
	4.0	8.38	10.7	96.34	21.7	3.00
	5.0	10.3	13.2	116.4	26.2	2.97
	5.4	11.1	14.0	123.8	27.8	2.97
	5.6	11.5	14.65	127.64	28.72	2.95
	6.3	12.8	16.2	141.2	31.8	2.93
	8.0	16.0	20.32	167.86	37.76	2.87
101.6	3.6	8.70	11.1	133.2	26.2	3.47
	4.0	9.63	12.3	146.2	28.8	3.45
	5.0	11.9	15.2	177.5	34.9	3.42
114.3	3.2	8.77	11.16	172.33	30.15	3.93
	3.6	9.83	12.5	192.0	33.6	3.92
	4.5	12.2	15.5	234.3	41.0	3.89
	5.4	14.5	18.5	274.5	48.0	3.86
	6.3	16.8	21.2	315.0	55.1	3.83
	8.0	21.0	26.3	377.6	66.0	3.78
	8.8	22.9	29.15	408.38	71.46	3.74

<i>Outside Diameter</i> mm (1)	<i>Thickness</i> mm (2)	<i>Mass</i> kg/m (3)	<i>Area of Cross-Section</i> cm ⁴ (4)	<i>Moment of Inertia</i> cm ⁴ (5)	<i>Modulus of Section</i> cm ³ (6)	<i>Radius of Gyration</i> cm (7)
127.0	4.5	13.6	17.3	325.3	51.2	4.33
	5.0	15.0	19.2	357.1	56.2	4.32
	5.4	16.2	20.6	302.0	60.2	4.30
139.7	3.6	12.1	15.38	356.36	51.02	4.81
	4.0	13.4	17.04	392.57	56.20	4.80
	4.5	15.0	19.1	437.2	62.6	4.78
	5.0	16.6	21.2	480.5	68.8	4.77
	5.4	17.9	22.8	514.5	73.7	4.75
	6.3	20.7	26.3	591.0	84.7	4.73
	8.0	26.0	32.5	716.0	103.0	4.71
	10.0	32.0	40.73	861.55	123.34	4.60
152.4	4.5	16.4	20.9	572.2	75.1	5.23
	5.0	18.2	23.2	629.5	82.6	5.21
	5.4	19.6	24.9	674.5	88.5	5.20
165.1	4.5	17.8	22.7	732.6	88.7	5.68
	5.0	19.7	25.1	806.6	97.7	5.66
	5.4	21.2	27.1	864.7	105.0	5.65
	6.3	24.8	31.4	992.0	120.0	5.63
168.3	4.0	16.2	20.64	696.87	82.81	5.81
	4.5	18.2	23.2	777.2	98.4	5.79
	5.0	20.1	25.7	855.8	102	5.78
	5.4	21.7	27.6	917.7	109	5.76
	6.3	25.2	32.1	1 053	125	5.73
	7.1	28.2	35.94	1 169.66	139	5.70
	8.0	31.6	39.7	1 288	153	5.69
	11.0	42.7	54.33	1 688.60	200.67	5.58
193.7	5.0	23.3	29.6	1 320	136	6.67
	5.4	25.1	31.9	1 417	146	6.66
	5.9	27.3	34.8	1 536	159	6.64
	6.3	29.1	37.0	1 600	165	6.60
	8.0	36.6	46.3	2 004	207	6.57

<i>Outside Diameter</i> mm (1)	<i>Thickness</i> mm (2)	<i>Mass</i> kg/m (3)	<i>Area of Cross-Section</i> cm ⁴ (4)	<i>Moment of Inertia</i> cm ⁴ (5)	<i>Modulus of Section</i> cm ³ (6)	<i>Radius of Gyration</i> cm (7)
219.1	4.5	23.8	30.32	1 746.18	159.4	7.59
	5.0	26.4	33.6	1 928	176	7.57
	5.6	29.5	37.6	2 142	195	7.56
	6.3	33.1	42.0	2 404	219	7.54
	8.0	41.6	52.0	1 940	268	7.52
	12.5	63.7	81.09	4 342.35	396.38	7.32
244.5	5.9	34.2	44.2	3 149	258	8.44
	7.1	41.7	53.5	3 776	308	8.42
	8.0	46.1	50.4	4 130	338	8.40
273.0	5.0	33.0	42.08	3 779.25	276.87	9.48
	6.3	41.4	52.5	4 745	348	9.51
	7.1	46.6	59.0	5 290	388	9.48
	10.0	64.9	82.6	7 154	524	9.31
323.9	5.6	44.0	55.97	7 094.44	438.06	11.3
	7.1	55.5	70.4	8 910	549	11.3
	8.0	62.3	78.0	9 830	616	11.2
	10.0	77.4	98	12 158	750	11.1
355.6	5.6	48.3	61.54	9 425.72	530.13	12.4
	8.0	68.6	87.32	13 195.12	742.13	12.3
	10.0	85.2	108.6	16 223	912	12.2
	11.0	93.5	119.02	17 684.91	994.65	12.2
	12.5	106.0	133.0	19 820	1 115	12.2
406.4	6.3	62.2	79.15	15 841.84	779.62	14.2
	8.8	86.3	109.86	21 719.76	1 068.89	14.1
	10.0	97.8	124.5	24 475	1 204.5	14.0
	12.5	121.0	153.0	30 020	1 475.0	14.0

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